

CLAIMS

1. An angular velocity sensor comprising:

a tuning fork vibrator including at least two arms,
5 and a base to connect the at least two arms;

a drive unit which is provided on a main surface
of an arm of the at least two arms of the tuning fork
vibrator so as to excite the tuning fork vibrator in one
of an X direction and a Z direction of the tuning fork
10 vibrator;

a detection unit which is provided on the main
surface of the arm of the at least two arms of the tuning
fork vibrator so as to detect bending of the tuning fork
vibrator vibrating in the Z direction in response to
15 incoming angular velocity;

a first drive circuit which makes the drive unit
excite the tuning fork vibrator in the X direction;

a detection circuit which includes an amplifier for
amplifying a signal from the detection unit and producing
20 an angular velocity signal;

a second drive circuit which applies a drive signal
to the drive unit so as to make the drive unit excite
the tuning fork vibrator in the Z direction; and

a self-diagnostic circuit which compares an output
25 of the amplifier with a reference value when the second

drive circuit applies the drive signal to the drive unit, and which determines to be abnormal when a prescribed value cannot be obtained.

5 2. The angular velocity sensor according to claim 1, wherein

at turn-on, the second drive circuit is first activated so that the self-diagnostic circuit can perform self diagnosis, and after a mode transition occurs, the
10 first drive circuit is activated so that detection of angular velocity can be performed in a predetermined manner.

3. The angular velocity sensor according to claim 1,
15 wherein

after the first drive circuit is activated and detection of angular velocity is continued for a prescribed length of time, the second drive circuit is activated so that the self-diagnostic circuit can perform
20 self diagnosis, and then, the first drive circuit is activated again so that the detection of angular velocity can be performed again.

4. The angular velocity sensor according to claim 1,
25 wherein

the second drive circuit is activated when it is detected that a car is at a speed of zero, and the self-diagnostic circuit performs self diagnosis.

5 5. The angular velocity sensor according to claim 1, wherein

the tuning fork vibrator is made of a non-piezoelectric material,

the drive unit includes:

10 a first, second, third and fourth electrodes which are formed separately from each other inside and outside a center line on the main surface of each of the at least two arms of the tuning fork vibrator;

a first, second, third and fourth
15 piezoelectric thin films which are respectively formed on the first, second, third and fourth electrodes; and

a fifth, sixth, seventh and eighth electrodes which are respectively formed on the first, second, third and fourth piezoelectric thin films, the fifth, sixth,
20 seventh and eighth electrodes being applied with drive signals of a same phase by the second drive circuit,

the detection unit includes:

a ninth electrode which is formed on the main surface of one of the at least two arms separately from
25 the first and second electrodes;

a fifth piezoelectric thin film which is formed on the ninth electrode;

a tenth electrode which is formed on the fifth piezoelectric thin film;

5 an 11th electrode which is formed on the main surface of an other of the at least two arms separately from the third and fourth electrodes;

a sixth piezoelectric thin film which is formed on the 11th electrode; and

10 a 12th electrode which is formed on the sixth piezoelectric thin film, and

the self-diagnostic circuit includes:

a first amplifier which is connected with the tenth electrode;

15 a second amplifier which is connected with the 12th electrode;

a differential amplifier which differentially amplifies an output of the first amplifier and an output of the second amplifier; and

20 a comparator which compares an output of the differential amplifier with a reference value.

6. The angular velocity sensor according to claim 1, wherein

the tuning fork vibrator is made of a non-piezoelectric material,

the drive unit includes:

a first, second, third and fourth electrodes
5 which are formed separately from each other inside and outside a center line on the main surface of each of the at least two arms of the tuning fork vibrator;

a first, second, third and fourth piezoelectric thin films which are respectively formed
10 on the first, second, third and fourth electrodes; and

a fifth, sixth, seventh and eighth electrodes which are respectively formed on the first, second, third and fourth piezoelectric thin films, the fifth, sixth, seventh and eighth electrodes being applied with drive
15 signals of a same phase by the second drive circuit,

the detection unit includes:

a ninth electrode which is formed on the main surface of one of the at least two arms separately from the first and second electrodes;

20 a fifth piezoelectric thin film which is formed on the ninth electrode;

a tenth electrode which is formed on the fifth piezoelectric thin film;

an 11th electrode which is formed on the main surface of an other of the at least two arms separately from the third and fourth electrodes;

a sixth piezoelectric thin film which is
5 formed on the 11th electrode; and

a 12th electrode which is formed on the sixth piezoelectric thin film, and

the self-diagnostic circuit includes:

a first amplifier which is connected with the
10 tenth electrode;

a second amplifier which is connected with the 12th electrode;

a first comparator which compares an output of the first amplifier with a reference value; and

15 a second comparator which compares an output of the second amplifier with a reference value.

7. The angular velocity sensor according to claim 6, wherein

20 the self-diagnostic circuit further includes:

a differential amplifier which receives the output of the first amplifier and the output of the second amplifier; and

a comparator which compares an output of the
25 differential amplifier with a reference value.